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Quality of Care for Cardiometabolic Disease:

Associations With Mental Disorder and Rurality

Nancy E. Morden, MD, MPH^{*,†,‡}, Ethan M. Berke, MD, MPH^{*,†,‡}, Deborah E. Welsh, MS[§], John F. McCarthy, PhD, MPH^{§,¶}, Todd A. Mackenzie, PhD^{||}, and Amy M. Kilbourne, PhD, MPH^{§,¶}

^{*}Department of Community and Family Medicine, Dartmouth Medical School, Hanover, NH

[†]The Dartmouth Institute for Health Policy and Clinical Practice, Lebanon, NH

[‡]VA White River Junction Rural Health Resource Center – Eastern Region, White River Junction, VT

[§]VA Ann Arbor HSR&D Center of Excellence, National Serious Mental Illness Treatment Research and Evaluation Center, Ann Arbor, MI

[¶]University of Michigan Department of Psychiatry, Ann Arbor, MD

^{||} Department of Medicine, Section of Clinical Research, Dartmouth Medical School, Hanover, NH

Abstract

Background—This study examines quality of cardiometabolic care among veterans receiving care in the Veterans Affairs (VA) health system. We assess whether quality of care disparities by mental disorder status are magnified for individuals living in rural areas.

Research Design—We identified all patients in a 2005 national Veterans Administration cardiometabolic quality of care chart review. The intersection of this cohort and VA registries, that include patients with and without mental disorder, permitted identification of chart review patients with and without mental disorder. Using residential ZIP code, patients were assigned to rural-urban commuting area codes. We used logistic regression adjusting for age, demographics, comorbidities, and income.

Measures—We assessed association between rural residence and 9 cardiometabolic care quality indicators including care processes and intermediate outcomes.

Results—Compared with those without mental disorder, patients with mental disorder were less likely to receive diabetes sensory foot exams (OR: 0.82; 95% CI: 0.72–0.94), retinal exams (OR: 0.82; 95% CI: 0.73–0.93), and renal tests (OR: 0.79; CI: 0.74–0.90). Rural residence was associated with no differences in quality measures. Primary care visit volume was associated with significantly greater likelihood of obtaining diabetic retinal examination and renal testing, but did not explain disparities among patients with mental disorder.

Conclusions—Mental disorder is associated with lesser attainment of quality cardiometabolic care. In this integrated VA care system, rurality and visit volume did not explain this disparity. Other explanations for disparities must be explored to improve the health and health care of this population.

Keywords

Mental Disorders; Cardiovascular Diseases; Rural Health Services; Health Care Disparities

Serious mental disorders (schizophrenia, other psychoses, and bipolar disorder) and depression are associated with excess cardiometabolic disease and mortality.^{1–6} Some excess cardiometabolic illness is attributed to health behaviors such as smoking and inactivity; some may result from metabolic effects of newer generation psychotropics.^{7–9} Excess cardiometabolic disease and poor outcomes could also result from disparities in access to and quality of medical care.^{10–14}

In the general population, rural residence is associated with lower levels of health services use, lesser quality of some health care, and higher prevalence of some diseases.^{15–19} Rural residence may impact receipt of quality care through limited clinical access (time and space obstacles) and availability (provider capacity), which have been linked to diminished care continuity and health services use.^{20,21}

Given these 2 distinct risk factors for receipt of lower care quality, we aimed to quantify the impact of an interaction between mental disorder (MD) and rurality on cardiometabolic care. Few studies have assessed the impact of rurality on the physical health care of patients with MD. Among MD patients, the effect of access and availability barriers, observed in the general population residing in rural areas, may be magnified by psychiatric symptoms, limited organizational skills, social isolation, distrust, and substance abuse. These factors may be particularly important if rural residence results in insufficient mental health care.^{22,23}

Studies have not determined if patients with MD experience greater disparities in rural settings, compared with urban settings. And, studies have not assessed differences in service use that may mediate care disparities. This study aimed to determine the association between rurality of residence and receipt of quality cardiometabolic care among Veterans Affairs (VA) patients with MD. We hypothesized that rural residence would interact with MD and result in greater quality of care disparities than MD or rurality alone. We hypothesized that fewer outpatient visits (especially primary care visits) would explain associations between rurality and quality and between MD and quality as visits represent opportunities to achieve quality indicators.

Methods

This study is based on a national, random sample of VA medical records reviewed in 2005 for cardiometabolic care quality indicators. The methods have previously been described.²⁴ Briefly, outpatient records were reviewed by trained nurse abstractors in the VAs External Peer Review Program (EPRP). The intersection of this cardiometabolic care review cohort

and VA registries that include patients with and without MD, permitted identification of EPRP patients with and without MD (Fig. 1). From this intersection, 2 study subcohorts were established: EPRP patients with (1) diabetes mellitus (DM) and (2) hypertension (HTN). The registries used for identification of EPRP patients with and without MD were: (1) the VA National Psychosis Registry, (2) the VA National Registry for Depression, and (3) the VA Serious Mental Illness Treatment and Evaluation Center's random sample of health systems users (for patients without MD). These registries include all veterans with registry specific diagnoses for schizophrenia, other psychoses, and bipolar disorder (ICD-9 codes: 295.0–295.4; 295.6–295.9) or depression (ICD-9 codes: 293.83, 296.2, 296.3, 298.0, 300.4, 301.12, 309.0, 309.1, 309.28, and 311). Random sample cohorts include patients with no MD diagnosis. Using residential ZIP codes, patients were assigned to 1 of 3 Rural Urban Commuting Area (RUCA) codes: (1) urban, (2) large rural city/town, or (3) small/isolated rural town.^{25–28}

EPRP cardiometabolic quality measures included care processes and intermediate outcomes reflecting American Heart Association and American Diabetes Association guidelines.^{29,30} For both cohorts measures included most recent blood pressure (BP) 160/100 and BP 140/90. Among patients with diabetes, quality indicators included: renal testing, retinal examination, and sensory foot examination in the past 12 months, most recent low density lipoprotein (LDL) 100, and most recent glycosylated hemoglobin >9.0.

Multivariable logistic regression determined the probability of receiving processes or intermediate outcomes, adjusting for MD diagnosis (categorized as any or none), RUCA (1–3), age, gender, race (dichotomized as black/nonblack),³¹ marital status (dichotomized as married/not married), substance abuse diagnosis (dichotomized as some/none), Charlson comorbidity index score,³² number of VA outpatient visits, number of visits to a VA community-based outpatient clinic (CBOC) and VA cost share category (income indicator).³³ For the DM cohort, diabetes was excluded from the Charlson Comorbidity Index. We selected variables on the basis of previous studies and our expectations of the relationship between these variables and quality measures.^{13,24,34,35} The reference group included patients with no MD and RUCA 1 (urban) residence as we expected the fewest care obstacles for this group.

To address our hypothesis that rurality and MD would interact and magnify disparities, we included interaction terms of RUCA level and MD. To determine the impact of service use differences, a second set of regression models included number of primary and specialty outpatient visits. We included CBOC visits to assess how care in these centers, established to enhance access, may impact care quality. Bonferroni methods corrected for multiple comparisons, with significance set to $P < 0.025$ for the HTN cohort (2 outcomes) and $P < 0.0071$ for the DM cohort (7 outcomes).

Results

Study patients reflect the VA population, predominantly male and older³⁶ (Table 1). Overall, 23,780 patients were sampled for HTN and 11,688 for DM care quality. Compared with RUCA 1 (urban) veterans, veterans residing in rural areas (RUCA 2 and 3) were

slightly older and more likely married, nonblack, and meeting means test for cost share; they were less likely to have a VA hospitalization. Average Charlson scores were slightly lower in veterans residing in rural areas compared with veterans residing in urban areas. Urban areas had proportionally more patients with MD: 32% to 34% in RUCA 1, compared with 30% to 33% and 27% to 38% in RUCA 2 and 3, respectively. Substance abuse was more prevalent in urban patients (11%–13%) than rural, RUCA 2 and 3 patients (7%–9% and 6%–8%, respectively). Average primary care and specialty visit volume reached statistically but not clinically significant difference across RUCAs. CBOC use was highest in RUCA 1 DM patients (average, 4.1 visits) and lowest among RUCA 1 HTN patients (average, 1.60 visits). Within cohorts, CBOC use differences were significant but did not follow a discernible pattern across the rural urban continuum.

Unadjusted analyses by MD status and RUCA revealed patients with MD and DM received sensory foot examination and achieved LDL goal, only half as often as those without MD. In this crude analysis, quality indicators did not vary significantly by RUCA (Table 2).

Multivariate logistic regression models were run initially with no visit volume or interaction terms. Addition of these variables and terms changed estimates associated with other variables trivially, therefore only the full model is presented in Table 3.

Compared with those without MD, patients with diabetes with MD were less likely to have sensory foot exams (OR: 0.82, 95% CI: 0.72–0.94), retinal examination (OR: 0.82, 95% CI: 0.73–0.94), or renal testing (OR: 0.79, 95% CI: 0.70–0.88). Compared with RUCA 1, living in more rural settings (RUCA 2 or 3) was not associated with lower quality for any measure assessed. Overall, 1 additional primary care visit was associated with better quality for 2 of 7 diabetic care processes (renal testing [OR: 1.08, 95% CI: 1.05–1.10] and retinal evaluation [OR: 1.03, 95% CI: 1.02–1.05]). An additional specialty care visit was associated with a 20% lower likelihood of achieving BP control for the DM and HTN cohorts. While visit volume was associated with differences in some quality measures, addition of visit volume to the initial model without this variable resulted in no appreciable change in estimates associated with other variables, and so visit volume did not explain lesser care quality for patients with MD. Interaction terms for MD and RUCA 2 or RUCA 3 revealed no significant associations. In the HTN cohort, an additional CBOC visit (OR: 1.01, 95% CI: 1.003–1.02) and an additional hospitalization (OR: 1.11, 95% CI: 1.02–1.21) were associated with greater likelihood of achieving good BP control.

Regarding other covariates, being unmarried was associated with a significantly greater likelihood of having poor HTN control. Black race was associated with poor blood pressure control, with or without DM, and less attainment of diabetic LDL goal. Higher age was associated with greater diabetic care quality: a higher likelihood of achieving LDL goal and retinal examination and a lower likelihood of having poor glucose control (AIC >9.0). Substance abuse diagnosis was associated with a 30% lower likelihood of receiving diabetic retinal examination. Higher Charlson comorbidity Index score was associated with greater likelihood of obtaining diabetes monitoring tests. More hospitalizations were associated with achievement of diabetic LDL goal. Lower income was associated with a higher likelihood of

receiving diabetic retinal exams and a lower likelihood of achieving good BP control in the HTN cohort (Table 3).

Discussion

Patients with MD achieved fewer cardiometabolic care processes, specifically diabetic renal testing, sensory foot exams, and retinal exams. In the VA system, rurality was not associated with lower cardiometabolic care quality. Although primary care visit volume was associated with greater care quality, visit volume differences did not explain lower care quality obtained by those with MD. Of measures assessed, all except diabetic retinal examination could be achieved in a primary care office, and thus reflect primary care access and quality. Failure to obtain a retinal examination may reflect unmeasured obstacles to specialist care.

Findings of previous studies of physical health care among patients with MD have reported either equal or inferior care quality for this population.^{10,11,13,14,34,37,38} We aimed to explore the contribution of rural residence to previously observed disparities. VA system integration, effective electronic medical records, and explicit efforts to address the needs of patients living at a significant distance from VA medical centers with CBOCs may explain the lack of association between rurality and care quality we observed.^{39,40}

The independent association of MD and lesser cardiometabolic care quality could be due to unobserved patient, clinician, and system factors.⁴¹ People with MD are less likely than those without MD to seek care and adhere to treatments.⁴² Lower educational attainment and less social connection may also negatively impact achievement of quality care processes and intermediate outcomes among those with MD. Physical medicine specialists may be uncomfortable or lack skills to effectively treat patients with some MD diagnoses.⁴³ Psychiatrists may not believe physical health is their responsibility or may not feel knowledgeable about physical medicine.⁴⁴ MD may distract attention from other diagnoses, such as HTN and DM.⁴⁵

This study has limitations worth considering. This cross-sectional, observational analysis does not permit conclusions regarding the causal relationships or care quality over time. We cannot adjust for severity or duration of illness which may impact outcomes measured. Following RUCA assignment, our study was insufficiently powered to permit separate analysis of patients with depression and patients with serious MD. In a study not adjusted for rurality, we reported a decreased likelihood of receiving quality cardiometabolic care in patients with serious MD or depression compared with patients without MD.²⁴ The effect of rurality may differ by MD type and severity. Patients may have received guideline concordant care through non-VA payers. The impact of these missing care data would depend on the relative tendency of rural, urban, mentally ill, and not mentally ill patients to use non-VA services.

Conclusions

Despite advances in chronic disease care models and increasing recognition of the disproportionate burden of cardiometabolic disease among people with MD, care disparities persist. We were encouraged to see rurality in this population was not associated with

disparities. This may be attributable to the integrated VA care system. Most disparity associated with MD reflects failure to obtain processes of care and not failure to achieve intermediate outcomes. Obstacles unique to the MD population should be assessed in future research and addressed in the development of care models for this population. Future work should assess outcomes associated with integrated mental and physical health care models being developed and implemented within and outside of the VA. Exploration of patient, clinician, and system contributions to this disparity is needed to inform future care models that reduce the physical illness burden of this population sufficiently burdened by MD.

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Study Population:

Figure 1.

Creation of study cohort: the intersection of the Veterans Administration External Peer Review Program and patient registries maintained by the Veterans Administration Serious Mental Illness and Treatment Evaluation Center.

Table 1
Distribution of Patient Characteristics, and Selected Service Use for Each of Two Cardiometabolic Chart Review Groups (Hypertension and Diabetes) by Rurality of Patient Residence

	Overall	RUCA 1	RUCA 2	RUCA 3	P*
Hypertension chart review cohort					
Average age (SD)	N = 23,780 67.00 (11.8)	N = 17,312 66.75 (12.0)	N = 2924 67.66 (11.6)	N = 3544 67.68 (11.1)	<0.0001
Male, N (%)	22,985 (96.8)	16,683 (96.6)	2841 (97.2)	3461 (97.8)	0.0003
Not married, N (%)	9713 (40.9)	9711 (56.1)	1936 (66.2)	2420 (68.3)	<0.0001
African American (black), N (%)	2397 (10.1)	2144 (12.4)	106 (3.6)	147 (4.2)	<0.0001
Average Charlson score (SD)	1.07 (1.6)	1.10 (1.6)	0.98 (1.4)	1.04 (1.5)	0.0004
Met means testing criteria for VA cost share, N (%) [†]	5214 (23.1)	3680 (22.4)	715 (25.7)	819 (24.3)	0.0001
Any substance abuse diagnosis, N (%)	2840 (11.9)	2290 (13.2)	267 (9.1)	283 (8.0)	<0.0001
Mental illness diagnosis, N (%)	7492 (31.5)	5602 (32.4)	902 (30.9)	988 (27.9)	<0.0001
Average number of VA outpatient medical specialty visits 2005 (SD)	0.01 (0.2)	0.01 (0.2)	0.02 (0.3)	0.01 (0.2)	0.3057
Average number of VA outpatient primary care visits 2005 (SD)	3.78 (3.7)	3.88 (3.9)	3.54 (3.3)	3.49 (3.2)	<0.0001
Average number of primary care and medical specialty visits at CBOCs 2005 (SD) [‡]	1.65 (3.3)	1.60 (3.3)	1.89 (3.4)	1.69 (3.2)	<0.0001
No. subjects with VA hospitalizations, N (%)	3552 (14.9)	2702 (15.6)	359 (12.3)	491 (13.9)	<0.0001
Diabetes chart review cohort					
Average age (SD)	N = 11,688 66.04 (11.1)	N = 8610 65.77 (11.2)	N = 1427 66.42 (11.0)	N = 1651 67.11 (10.2)	<0.0001
Male, N (%)	11,388 (97.5)	8376 (97.4)	1396 (97.9)	1616 (97.9)	0.2880
Not married, N (%)	4637 (39.7)	3653 (42.4)	459 (32.2)	525 (31.8)	<0.0001
African American (black), N (%)	1307 (11.2)	1175 (13.7)	68 (4.8)	64 (3.9)	<0.0001
Average Charlson score (SD)	2.03 (1.7)	2.07 (1.8)	1.92 (1.6)	1.93 (1.7)	0.0002
Met means testing criteria for VA cost share, N (%) [†]	2187 (19.6)	1546 (18.9)	292 (21.4)	349 (22.1)	0.0030
Any substance abuse diagnosis, N (%)	1136 (9.7)	936 (10.9)	104 (7.3)	96 (5.8)	<0.0001
Mental illness diagnosis, N (%)	3801 (32.5)	2889 (33.6)	465 (32.6)	447 (27.1)	<0.0001
Average number VA outpatient medical specialty visits 2005 (SD)	0.01 (0.3)	0.01 (0.2)	0.02 (0.3)	0.01 (0.3)	0.8708
Average number of VA outpatient primary care visits 2005 (SD)	4.05 (4.1)	4.15 (4.2)	3.73 (3.5)	3.78 (3.5)	<0.0001
Average number of primary care and medical specialty visits at CBOCs 2005 (SD) [‡]	3.85 (9.2)	4.10 (10.0)	3.14 (5.8)	3.17 (6.6)	<0.0001
No. subjects with VA hospitalizations N (%)	2,395 (20.5)	1869 (21.7)	233 (16.3)	293 (17.8)	<0.0001

Mental illness includes all patients with at least one inpatient or outpatient ICD-9 diagnosis of schizophrenia, bipolar disorder, other nonorganic psychoses or depression.

RUCA is 3-tier rural urban commuting code level. RUCA 1 is urban, RUCA 2 is large rural city or town, RUCA 3 is small or isolated rural town.

* χ^2 for discrete and t test for continuous variables.

[†] Means testing for cost share within the veterans administration.

[‡] CBOC—community based outpatient clinic.

VA indicates veterans affairs.

Table 2
Quality of Cardiometabolic Care Bivariate Results by Mental Illness Status and by Rural Classification of Patient Residence (RUCA 1-3)

	HTN and BP 160/100	HTN Dx and BP 140/90	DM and LDL <100	DM and Obtained Sensory Foot Exam	DM and Obtained Retinal Exam	DM and Obtained Renal Testing	DM and HbA1C >9.0	DM and BP < 140/90	DM and BP > 160/100
Mental illness, N (%)	561 (31.46)	5471 (31.37)	1452 (35.02)*	2802 (31.66)*	2750 (32.16)	2625 (32.32)	49 (37.40)	2662 (32.76)	230 (30.96)
No mental illness, N (%)	1222 (68.54)	11,968 (68.63)	2694 (64.98)	6049 (68.34)	5802 (67.84)	5498 (67.68)	82 (62.60)	5464 (67.24)	513 (69.04)
RUCA 1 (urban), N (%)	1328 (74.48)	12,640 (72.48)	3072 (74.10)	6476 (73.17)	6297 (73.63)	5955 (73.31)	108 (82.44)	5955 (73.28)	553 (74.43)
RUCA 2, N (%)	213 (11.95)	2157 (12.37)	497 (11.99)	1092 (12.34)	1037 (12.13)	997 (12.27)	14 (10.69)	1012 (12.45)	79 (10.63)
RUCA 3 (most rural), N (%)	242 (13.57)	2642 (15.15)	577 (13.92)	1283 (14.50)	1218 (14.24)	1171 (14.42)	9 (6.87)	1159 (14.26)	111 (14.94)

Each column represents 2 unique models. In the top 2 rows of each column, quality of care indicator in the group with mental illness was compared to that of the group without mental illness. In the bottom 2 rows of each column, values were compared across populations residing in each RUCA level.

Chi square test was used to assess differences in percent of subgroups with the care indicator. Significance set using Bonferroni methods were corrected for multiple comparisons, based on number of outcomes measured for each cohort.

RUCA is 3-tier rural urban commuting code level. RUCA 1 is urban, RUCA 2 is large rural city or town, RUCA 3 is small or isolated rural town.

Mental illness includes all patients with at least one inpatient or outpatient ICD-9 diagnosis of schizophrenia, bipolar disorder, other non-organic psychoses, or depression.

* $P < 0.007$.

BP indicates most recent outpatient blood pressure measurement; DM, diabetes mellitus; HTN, is hypertension; HbA1C, glycosylated hemoglobin; LDL, most recent low-density lipoprotein measurement.

Quality of Cardiovascular Care: Multivariable Logistic Regression Including Interaction Terms for Mental Illness and Rurality of Residence

Table 3

	Among Subjects With Hypertension (N = 23,780)				Among Subjects With Diagnosis of Diabetes Mellitus (N = 11,688)					
	BP 160/100 OR (95% CI)	BP 140/90 OR (95% CI)	LDL <100 OR (95% CI)	Sensory Foot Exam OR (95% CI)	Retinal Exam OR (95% CI)	Renal Testing OR (95% CI)	HbA1C >9.0 OR (95% CI)	BP < 140/90	BP >160/100	
Not married vs. married	1.18 (1.06, 1.32)*	0.95 (0.89, 1.01)	1.02 (0.92, 1.14)	0.92 (0.82, 1.03)	0.95 (0.86, 1.06)	1.01 (0.92, 1.10)	0.94 (0.64, 1.39)	0.97 (0.90, 1.06)	1.07 (0.90, 1.27)	
Mental illness vs. no psychiatric DX	0.95 (0.83, 1.10)	1.02 (0.94, 1.11)	1.00 (0.89, 1.13)	0.82 (0.72, 0.94)***	0.82 (0.73, 0.93)***	0.79 (0.70, 0.88)**	1.05 (0.69, 1.59)	1.11 (0.99, 1.25)	0.88 (0.73, 1.07)	
Black vs. non-black	1.27 (1.06, 1.53)*	0.78 (0.70, 0.87)**	0.79 (0.67, 0.93)***	0.98 (0.82, 1.16)	1.14 (0.97, 1.33)	1.07 (0.93, 1.23)	1.36 (0.88, 2.11)	0.69 (0.60, 0.78)**	1.66 (1.31, 2.10)**	
Age, the effect of an increase of 1 year	1.00 (1.00, 1.01)	1.00 (1.00, 1.00)	1.03 (1.02, 1.04)**	1.00 (1.00, 1.01)	1.01 (1.00, 1.01)***	0.99 (0.99, 1.00)	0.97 (0.94, 0.99)***	1.00 (0.99, 1.00)	1.01 (1.00, 1.02)	
Gender, female vs. male	1.10 (0.83, 1.47)	1.05 (0.85, 1.28)	0.88 (0.65, 1.19)	0.86 (0.65, 1.14)	0.67 (0.51, 0.89)***	0.82 (0.64, 1.06)	1.14 (0.09, 14.26)	0.90 (0.68, 1.19)	1.13 (0.70, 1.82)	
Any substance abuse Dx vs. none	1.12 (0.94, 1.32)	0.93 (0.85, 1.03)	0.90 (0.78, 1.03)	0.85 (0.70, 1.03)	0.69 (0.60, 0.80)**	1.10 (0.93, 1.29)	1.12 (0.59, 2.13)	0.86 (0.74, 1.00)	1.13 (0.85, 1.49)	
Does not meet means test for cost share vs. does	1.06 (0.91, 1.23)	0.91 (0.85, 0.98)*	0.95 (0.82, 1.10)	1.12 (0.97, 1.29)	1.73 (1.54, 1.96)**	0.98 (0.88, 1.09)	0.91 (0.46, 1.81)	0.98 (0.87, 1.10)	0.84 (0.68, 1.04)	
No. VA outpatient primary care visits (OR associated with increase by one)	0.98 (0.96, 1.00)	1.00 (0.99, 1.01)	1.01 (1.00, 1.03)	1.02 (1.00, 1.04)	1.08 (1.05, 1.10)**	1.03 (1.02, 1.05)***	1.02 (0.95, 1.10)	0.99 (0.97, 1.00)	1.00 (0.98, 1.02)	
No. VA outpatient specialty visits (OR associated with increase by one)	1.07 (0.86, 1.33)	0.83 (0.74, 0.92)*	1.07 (0.71, 1.63)	0.96 (0.79, 1.16)	1.04 (0.79, 1.38)	0.96 (0.77, 1.20)	0.97 (0.72, 1.32)	0.81 (0.70, 0.93)***	1.04 (0.83, 1.31)	
No. primary care and/or medical specialty visits at CBOCs (OR associated with increase by one)	1.00 (0.99, 1.02)	1.01 (1.00, 1.02)*	1.00 (0.98, 1.02)	1.00 (0.98, 1.02)	0.97 (0.95, 0.99)	0.99 (0.98, 1.01)	1.01 (0.93, 1.11)	1.02 (1.00, 1.03)	1.00 (0.98, 1.02)	
Charlson comorbidity score, (OR associated with an increase by one)†	1.03 (1.00, 1.06)	1.00 (0.98, 1.02)	1.02 (0.99, 1.06)	1.08 (1.04, 1.12)**	1.06 (1.02, 1.09)***	1.08 (1.04, 1.12)**	1.03 (0.95, 1.12)	1.00 (0.97, 1.03)	1.02 (0.97, 1.07)	
RUCA 2 vs. RUCA 1	1.09 (0.91, 1.31)	0.92 (0.82, 1.03)	0.90 (0.74, 1.10)	0.96 (0.74, 1.24)	0.81 (0.67, 0.98)	0.97 (0.82, 1.14)	1.15 (0.53, 2.50)	0.93 (0.78, 1.11)	0.86 (0.62, 1.18)	
RUCA 3 vs. RUCA 1	0.91 (0.74, 1.10)	1.03 (0.93, 1.15)	0.95 (0.80, 1.13)	0.99 (0.84, 1.67)	0.86 (0.72, 1.02)	0.96 (0.82, 1.14)	0.65 (0.30, 1.42)	0.92 (0.80, 1.06)	0.99 (0.74, 1.31)	
No. VA hospitalizations (OR associated with an increase of one)	0.89 (0.76, 1.04)	1.11 (1.02, 1.21)*	1.25 (1.10, 1.42)*	0.91 (0.78, 1.05)	1.01 (0.87, 1.17)	1.19 (1.04, 1.35)	1.15 (0.75, 1.78)	1.07 (0.94, 1.22)	1.07 (0.86, 1.34)	
Interactions										
RUCA 2 × mental illness	0.73 (0.52, 1.03)	1.23 (1.00, 1.51)	0.97 (0.71, 1.33)	0.99 (0.71, 1.39)	1.44 (1.04, 1.99)	1.25 (0.93, 1.68)	0.88 (0.28, 2.80)	1.11 (0.82, 1.51)	1.04 (0.58, 1.85)	
RUCA 3 × mental illness	1.15 (0.83, 1.59)	0.91 (0.74, 1.11)	0.77 (0.56, 1.05)	0.89 (0.65, 1.22)	1.17 (0.87, 1.58)	1.26 (0.99, 1.61)	0.64 (0.11, 3.80)	0.81 (0.63, 1.06)	1.47 (0.97, 2.23)	

Multivariable logistic regression models were originally run with no interaction terms. As the addition of interactions terms resulted in trivial changes in estimates for the non-interaction variables, for brevity, only the full models including interactions terms are presented. Significance set using Bonferroni methods to correct for multiple comparisons, based on number of outcomes measured for each cohort. Each column represents a unique model.

RUCA is 3 tier rural urban commuting code level. RUCA 1 is urban, RUCA 2 is large rural city or town, RUCA 3 is small or isolated rural town.

Mental illness includes all patients with at least one inpatient or outpatient ICD-9 diagnosis of schizophrenia, bipolar disorder, other non-organic psychoses, or depression.

* $P < 0.025$,

*** $P < 0.0001$,
*** $P < 0.00714$.

¶Charlson comorbidity index modified by excluding diabetes diagnosis.

BP indicates the most recent outpatient blood pressure measurement; DM, diabetes mellitus; HTN, hypertension; HbA1C, glycosylated hemoglobin; LDL, most recent low-density lipoprotein measurement.